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Industrial Facilities
(Non-Military)

# Basic Imagery Interpretation Report

## China's Petrochemical Industry

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CENTRAL INTELLIGENCE AGENCY
Directorate of Intelligence
Imagery Analysis Service

# CHINA'S PETROCHEMICAL INDUSTRY

## ABSTRACT

A total of ten petrochemical complexes or plants have been identified to date on photography of China. They range from small Chinese-designed plants producing only a single product to large integrated complexes employing the latest Western technology. Three of these, large petrochemical complexes containing plants imported from Japan and western European countries, are scheduled to come on-stream in 1976 and 1977. These three complexes will enable the Chinese to produce greatly increased quantities of plastics, synthetic fibers, and probably synthetic rubber during the latter half of the 1970s.

We estimate that the total annual ethylene production capacity, the best indicator of a country's petrochemical capacity, will increase from under 50,000 metric tons in 1970 to about 585,000 metric tons in 1977. We estimate that over the same period plastics production from petroleum feedstocks will increase from 32,000 metric tons annually to about 390,000 metric tons, and synthetic fibers production from petroleum will increase from only minimal production to about 300,000 metric tons.

This report summarizes the development of the Chinese petrochemical industry and discusses the production capacities for the major categories of petrochemical products. It also includes a brief description and a photograph of each of the ten petrochemical complexes or plants.

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Comments and queries regarding this publication are welcomed. They may be directed to [redacted] of the Economic Resources Division, IAS, [redacted]

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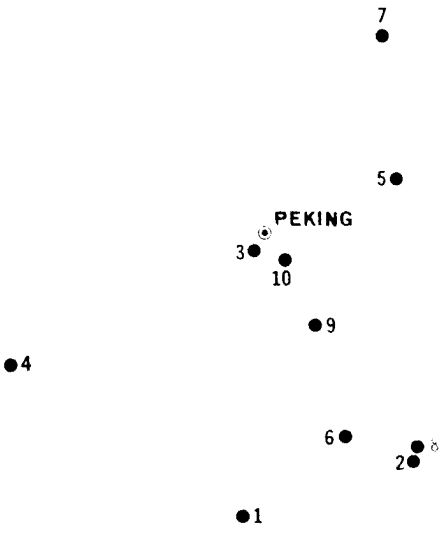


FIGURE 1. LOCATIONS OF CHINESE PETROCHEMICAL COMPLEXES OR PLANTS, JUNE 1976.

1. CHI-LIN-HSIANG
2. CHIN-SHAN-WEI
3. FANG-SHAN
4. LAN-CHOU
5. LIAO-YANG
6. NAN-CHING
7. SA-ERH-TU
8. SHANGHAI
9. WANG-CHU-CHUANG
10. YANG-LIU-CHING



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## INTRODUCTION

The rapid expansion of the Chinese petrochemical industry will enable China to produce increasing quantities of plastics, synthetic fibers, and probably synthetic rubber during the latter half of the 1970s (Tables 1 - 3). Most of this increased production will result from China's program of whole-plant purchases from the more industrialized non-Communist countries. In the past, the Chinese relied primarily on inefficient processes based on coal and inorganic chemicals to fulfill their requirements for those products which in the industrialized countries, are produced from petroleum feedstocks.

Ten petrochemical complexes or plants have been identified to date on photography of China -- nine in eastern China and one in the west, at Lan-chou (Figure 1). Table 2 lists the plants, their final products, and, where possible, their reported or estimated production capacities.

This report discusses in detail only those plants which use a petroleum or natural gas feedstock. The production capacity figures given for plastics, synthetic fibers, and synthetic rubber are based only on these plants and do not include the capacities of plants which use coal or other non-petroleum feedstocks.

Most of the production capacities for the imported plants involved in this report have been derived from collateral reporting. Although some collateral is available on the indigenous plants, most of their production capacities have been estimated by comparing them with similar plants in the USSR, Europe, and the U.S.

## DISCUSSION

### Development of the Industry

China's petrochemical industry is just beginning to emerge as a significant factor in its economy. In the 1950s, the Chinese lacked both the petroleum resources for petrochemical feedstocks and the technological expertise required for a significant output of petrochemical products. The discovery of the Ta-ching and Pohai oil fields in the early 1960s solved the problem of feedstock availability. Also in the early 1960s, the Chinese began a program to increase their technological expertise through the construction of a group of pilot-plant-sized petrochemical units at Shanghai. A small collocated ethylene plant, apparently of indigenous design, supplied the feedstocks for these units.



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By the mid-1960s, such small-capacity units could not satisfy China's need for petrochemical products. The Chinese, however, had developed neither the process technologies nor the metallurgical and fabrication expertise needed to construct large-scale processing units. As a result, they turned to the West for more modern, larger-capacity equipment, importing an integrated petrochemical complex with plants from both Great Britain and West Germany in 1964 and 1965. This complex was built in Lan-chou, at the site of an older grain-alcohol-based synthetic rubber plant, and came on-stream between 1966 and 1971. Although the capacity of the Lan-chou complex was not large -- the ethylene capacity was only about 40,000 metric tons per year (mt/yr) -- it did represent a major technological advance over earlier indigenous plants.

Completion of the Lan-chou complex may have been delayed by the Cultural Revolution and by a continuing lack of Chinese technological expertise. In any event, no more large petrochemical plant purchases were made in the 1960s. In the late 1960s, however, construction on a new Chinese-designed petrochemical complex began at Fang-shan, in a hilly area southwest of Peking. Although this complex produces a wide variety of products, the capabilities of the individual production units are, by world stands, very limited and certainly not adequate to fulfill China's growing need for petrochemical products.

In late 1972 and 1973, China began ordering petrochemical plants from Japan and the West. CIA/OER estimates that from 1973 to 1975 these orders amounted to $1.5 billion. 1/ They included ethylene plants, synthetic fibers plants, plastics plants, and ammonia/urea fertilizer plants. The large ammonia/urea plant import program will not be included in this report. It was previously discussed in an IAS Basic Imagery Interpretation Report. 2/

With the exception of the 13 urea fertilizer plants and the vinylon fibers plant at Chang-shou, all of the recently imported plants that have been observed under construction are at either the two new petrochemical complexes at Chin-shan-wei and Liao-yang or at the existing complex at Fang-shan. In contrast to the delays experienced in getting the imported plants at Lan-chou on-stream in the 1960s, construction at these three complexes is apparently proceeding on schedule.

Site preparation for the large Chin-shan-wei complex was observed in early 1973 and some units were complete by late 1975. At Fang-shan, site preparation for the imported units was under way in early 1974 and evidence of trial operation of the ethylene plant was observed in late 1975. The Liao-yang complex is still in an early stage of construction, with its units not scheduled to start coming on-stream until 1977.



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Petrochemical Production Capacity*

Feedstocks. The Fang-shan, Chin-shan-wei, and the Liao-yang complexes will each contain an ethylene plant to produce feedstocks for the other units in the complex. Since ethylene is the most common feedstock for petrochemical production, it is the best single indicator of total production capacity. China's ethylene capacity was approximately 48,000 mt/yr in 1970.** We project that by the end of 1976 this ethylene capacity will have increased more than tenfold to about 513,000 mt/yr and to 586,000 mt/yr by the end of 1977 (Figure 2). Production of propylene, another important petrochemical feedstock produced by the ethylene plants, will increase proportionately.

* Capacity estimates for Chinese units should be considered tentative.

** Capacity totals do not include ethylene recovered from refinery off-gas.

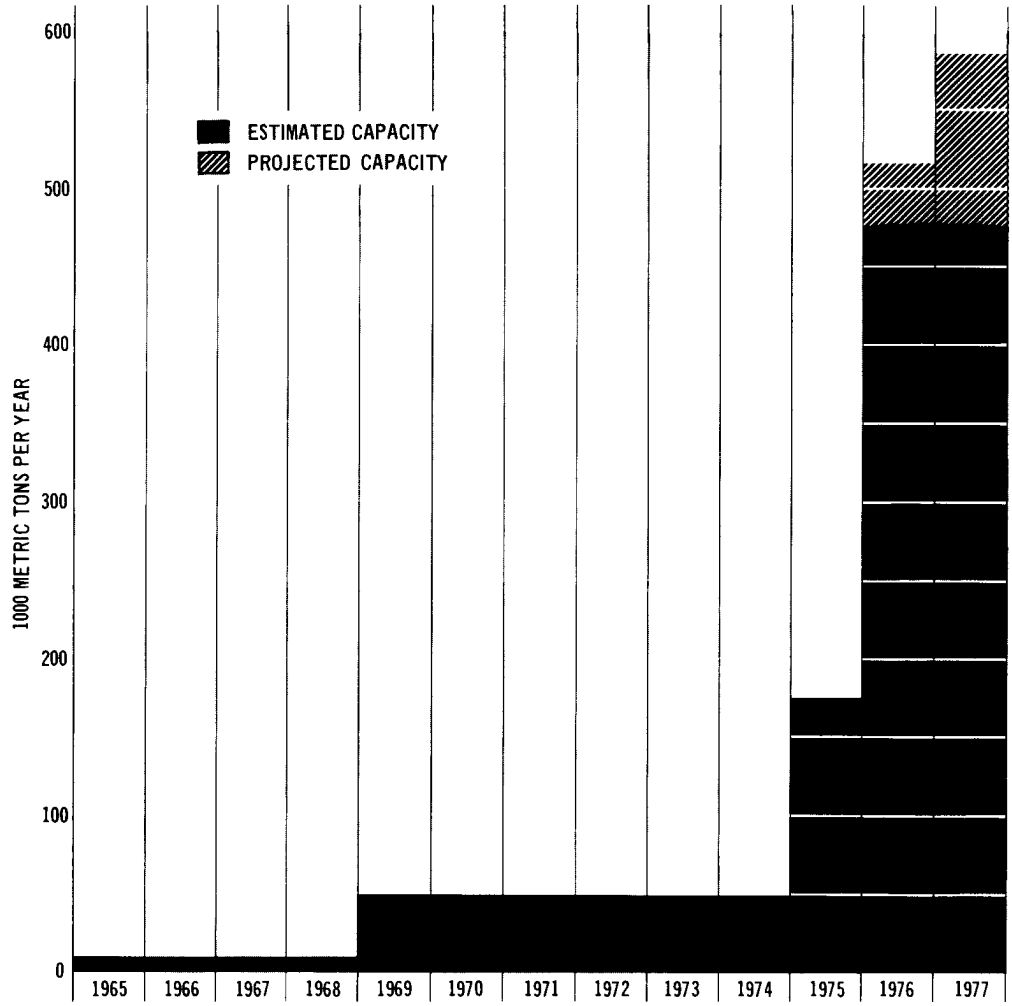


FIGURE 2. GROWTH OF ETHYLENE PRODUCTION CAPACITY OF THE CHINESE PETROCHEMICAL INDUSTRY.





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Table 1. Estimated Ethylene Production Capacity for 1977
(Metric Tons Per Year)

| | Complex | Capacity | Percent of Total Capacity | Remarks |
|---|---|---|---|---|
| 1. | Fang-shan | 300,000* | 51 | Imported. |
| 2. | Chin-shan-wei | 120,000* | 20 | Imported. |
| 3. | Lan-chou | 40,000* | 7 | Imported. |
| | | 40,000 | 7 | Copy of imported plant; under construction. |
| 4. | Liao-yang | 73,000* | 12 | Imported plant; under construction. |
| 5. | Shanghai | 8,000 | 2 | Chinese design. |
| 6. | Nan-ching | 5,000 | 1 | Chinese design. |
| | | 586,000 | 100% | |

*Reported capacities; others are estimated.

Despite the percentage increases anticipated, China's total ethylene production capacity will remain small by world standards. The 513,000 mt/yr of ethylene projected for 1976 is less than 5 percent of the United States' 1975 capacity. However, a single large ethylene plant, at Fang-shan, will produce about half of China's ethylene through 1977 (Table 1). Continued construction of such large-capacity plants would allow China's petrochemical feedstock capacity to continue to grow.

Production of petroleum aromatics (benzene, toluene and xylenes), another important category of petrochemical feedstocks, has been rising steadily as a result of increased catalytic reforming capabilities at Chinese petroleum refineries. The new ethylene plants will produce additional aromatics. One of these, paraxylene, is especially important as a feedstock for polyester fibers. No estimate of China's total aromatics production is available.

Figure 3 illustrates a simplified process flow from feedstock through final product for the petrochemical plants identified in China.



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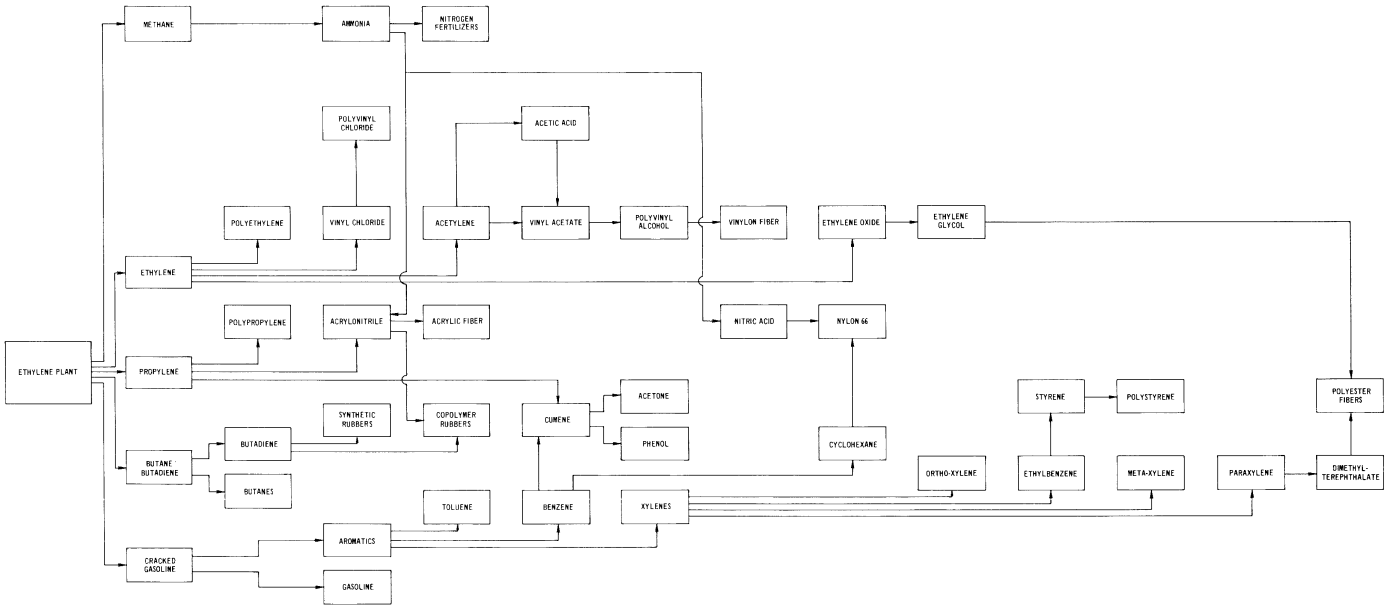


FIGURE 3. GENERAL PROCESS FLOW FOR CHINA'S PETROCHEMICALS.



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Table 2. Production of Final Products at Chinese Petrochemical Plants, May 1976

| | Synthetic Fibers | | | Plastics | | | Synthetic Rubber | | | Other Products | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Name | Type | Capacity (Metric Tons/ Year) | Completed | Type | Capacity (Metric Tons/ Year) | Completed | Type | Capacity (Metric Tons/ Year | Completed | Type | Capacity (Metric Tons/ Year) | Completed | Date of Information |
| Chi-lin-hsiang | Poss acrylic | Unknown | 1973 | | | | Polybutadiene UC | 11,000 | | Prob chlorine/ caustic soda | Unknown | 1973 | Dec 75 |
| | | | | | | | | | | Urea | Unknown | 1973 | |
| Chin-shan-wei | Acrylic | 50,000* | 1976 | Polyethylene | 60,000* | 1975 | | | | | | | Feb 76 |
| | Vinylon | 36,000* | 1975 | | | | | | | | | | |
| | Poss polyester UC | 25,000* | 1976 | | | | | | | | | | |
| Fang-shan | | | | Prob polypropylene | 2,000 | 1972 | Polybutadiene | 15,000 | 1972 | Phenol/acetone | Unknown | 1970 | Mar 76 |
| | | | | Polystyrene | 3,000 | 1972 | Poss polyisoprene | Unknown | 1973 | | | | |
| | | | | Polypropylene UC | 80,000* | 1976 | | | | | | | |
| | | | | Polyethylene UC | 180,000* | 1976 | | | | | | | |
| | | | | Vinyl chloride** | 80,000* | 1976 (1977) | | | | | | | |
| Lan-chou | Acrylic | 10,000* | 1971 | Polyethylene | 24,000* | 1969 | Butadiene/styrene | 5,000* | 1963 | | | | Jan 76 |
| | | | | Polypropylene | 8,000* | 1969 | Polybutadiene/nitrile | 20,000* | 1966 | | | | |
| Liao-yang | Polyester UC | 87,000* | 1977 | Prob polyethylene UC | 35,000* | 1977 | | | | | | | Mar 76 |
| | Nylon UC | 46,000* | 1977 | Polypropylene** | 35,000* | 1978 | | | | | | | |
| Nan-ching† | | | | | | | | | | | | | May 76 |
| Sa-erh-tu | Acrylic | 2,000 | 1972 | | | | | | | | | | Jun 75 |
| Shanghai | Poss acrylic | 1,500 | 1972 | Polystyrene | Small | 1972 | | | | Phenol/acetone | Unknown | 1971 | May 76 |
| | | | | Polyethylene | Small | 1972 | | | | | | | |
| Wang-chu-chuang | | | | | | | Polybutadiene | 11,000 | 1975 | | | | Dec 75 |
| Yang-liu-ching† | | | | | | | | | | | | | Mar 76 |
| TOTALS - | | 99,500 on-stream<br>158,000 under construction | | | 97,000 on-stream<br>295,000 under construction<br>115,000 projected for construction | | | 51,000 on-stream<br>11,000 under construction | | | | | |

*Reported capacities; others are estimated (see individual plant tables for primary and intermediate feedstock petrochemicals produced at these plants).

**Unit reported purchased but not yet observed on photography. Dates are for scheduled completion; the date in parentheses is estimated from photography.

†Final products of these plants cannot yet be determined.

Plastics Production. China's plastics production from petrochemical feedstocks was concentrated at Lan-chou in the early 1970s. Smaller quantities of plastics were produced at Fang-shan and Shanghai. Polyethylene was the most commonly produced plastic, accounting for 24,000 mt/yr out of a total capacity of 37,000 mt/yr. This emphasis on the production of polyethylene continued with the plants purchased from 1973 to 1975. We project that a plastics capacity of 392,000 mt/yr will be available when all of the plants observed under construction are in operation, probably during 1977 (Figure 4). Of this total, more than 75 percent (or 299,000 mt/yr) will be polyethylene. Polypropylene will account for nearly all of the remaining projected plastics capacity.

The major end products produced from polyethylene plastics are films and sheeting. Other less important products include moldings, cable and wire sheathing, and pipe. Polypropylene is most widely used in moldings, but it can also be used as a synthetic fiber.

The Fang-shan complex will be China's major plastics producer by the end of 1976. The 180,000 mt/yr capacity of a single polyethylene plant at Fang-shan will account for over 45 percent of China's projected plastics production capacity for 1977.

Synthetic Fibers Production. While Fang-shan will be the major producer of plastics, the two new imported petrochemical complexes, Chin-shan-wei and Liao-yang, will primarily produce synthetic fibers. The Chin-shan-wei complex, which began initial testing of some units in late 1975, should be in full operation in 1976. It will produce acrylic, vinylon, and polyester fibers, with a combined design capacity of 111,000 mt/yr. Liao-yang, scheduled to begin coming on-stream in 1977, will produce polyester and nylon fibers with a combined design capacity of 133,000 mt/yr.

In addition to the fibers facilities at these two complexes, we have observed two confirmed and two possible acrylic fibers plants in China. The oldest of the confirmed plants, at Lan-chou, was imported from West Germany and was first observed operating in 1971. The only other plant to be confirmed on photography, a small-capacity plant of indigenous design at Sa-erh-tu, became operational in 1972. The two possible acrylic fibers plants are at the Shanghai and Chi-lin-hsiang complexes. The small-capacity Shanghai plant appears to be Chinese designed. The Chi-lin-hsiang possible acrylic fibers plant has a much larger capacity, and the size and general layout of its equipment suggest that it was constructed with foreign aid. We are not yet able to estimate the capacity of the Chi-lin-hsiang plant.



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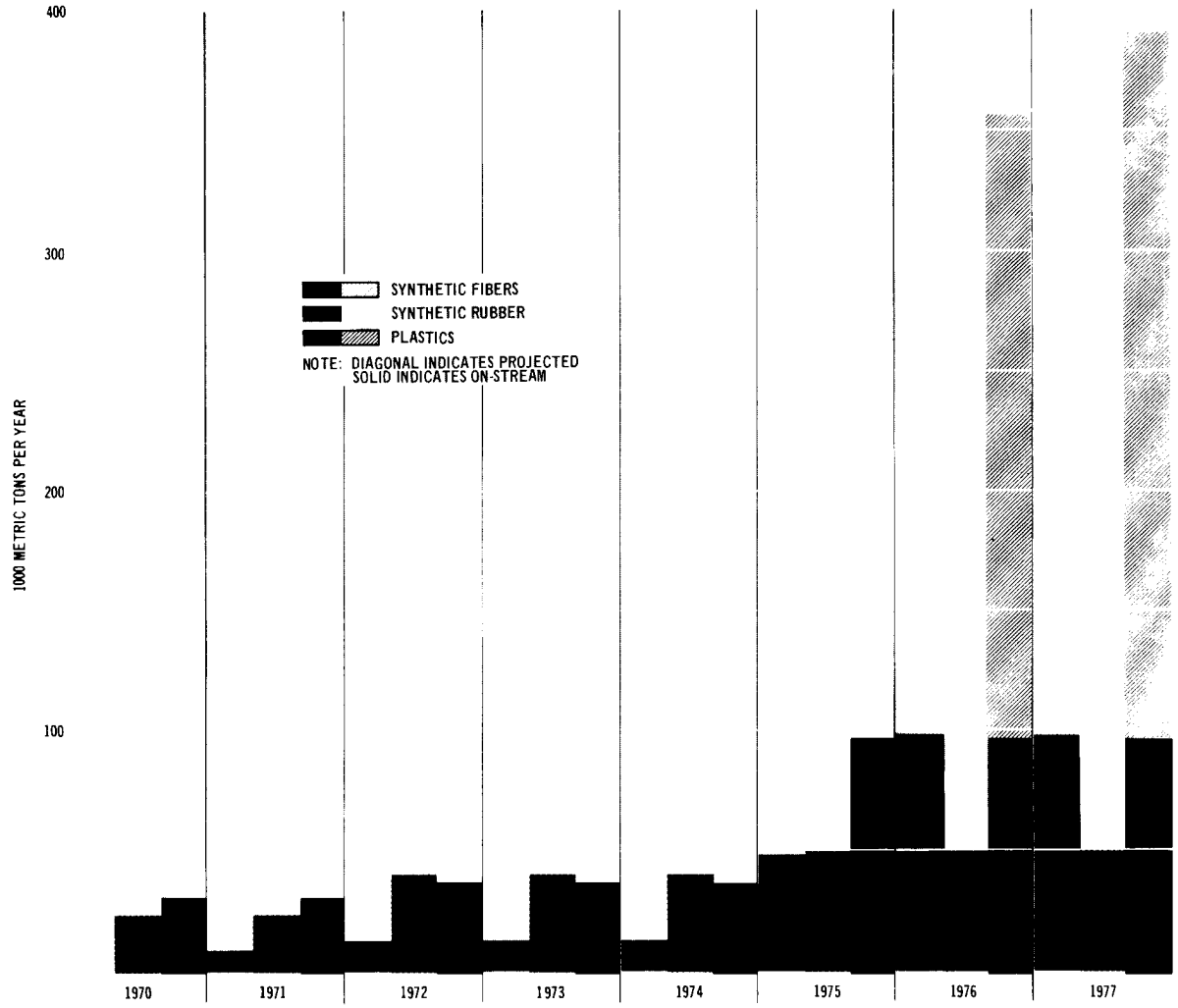


FIGURE 4. GROWTH OF CHINESE PETROCHEMICAL PRODUCTION CAPACITY, 1970-1977.
Note: Graph includes only the production capacity of those facilities identified on photography.

China's total estimated production capacity for synthetic fibers from petrochemical feedstocks was under 14,000 mt/yr prior to 1975 (Figure 4). As the recently imported plants come on-stream, this capacity is expected to rise to a total of 169,500 mt/yr by the end of 1976 and to 302,500 mt/yr by the end of 1977. This is about 10 percent of present US production. These total figures for China do not include production from China's vinylon plants (except the petroleum-based one which is integrated into the Chin-shan-wei Petrochemical Complex and the natural-gas-based Chang-shou plant). China's vinylon fiber industry was previously discussed in an IAS Imagery Interpretation report. 3/



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Table 3. Estimated Chinese Synthetic Fiber Production Capacity, 1974 - 1980
(Metric Tons Per Year)

| | 1974 | 1975 | 1976 | 1977 | 1980 |
|---|---|---|---|---|---|
| Acrylic | 13,500 | 13,500 | 63,500 | 63,500 | 63,500 |
| Nylon | -- | -- | -- | 46,000 | 46,000 |
| Polyester | -- | -- | 25,000 | 112,000 | 202,000* |
| Vinylon** | -- | 36,000 | 81,000 | 81,000 | 81,000 |
| Total | 13,500 | 49,500 | 169,500 | 302,500 | 392,500 |

*Includes the 90,000 mt/yr capacity of the dimethyl terephthalate (DMT) plant which has been purchased by the Chinese and which we believe will be built at Fang-shan. DMT is an intermediate in polyester production.

**Capacities of China's only vinylon plants using a petrochemical feedstock -- Chin-shan-wei and Chang-shou.

By 1977, polyesters will account for over 50 percent of China's total synthetic fibers production capacity, while at present, acrylic and vinylon fibers account for most of it. Additional amounts of synthetic fibers could also be made from polypropylene. Table 3 lists our estimates of China's production capacity for each of the four types of synthetic fibers from 1974 to 1980.

Synthetic Rubber Production. The Chinese are apparently experiencing technical problems in expanding their synthetic rubber industry. After relying primarily on imported plants and the foreign-designed Lan-chou plant in the 1960s, the first full-scale, domestic-designed, petroleum-based synthetic rubber plant was constructed at Fang-shan between 1970 and 1972. However, since its completion, Fang-shan reportedly has experienced production outages caused by process control or design problems.

Construction of a second domestic plant, similar in design to Fang-shan, began at Wang-chu-chuang in early 1971. Although construction of the plant proceeded slowly, it appeared to be capable of operation in late 1975. The plant, however, has not been observed in operation. A third domestic synthetic rubber plant, also similar to Fang-shan, has been under construction at the Chi-lin-hsiang complex since early 1972. Little progress has been made in the construction of this plant since 1973, and construction may have been discontinued. Operation and construction delays observed at the Wang-chu-chuang and Chi-lin-hsiang plants, respectively, may have resulted from problems similar to those encountered at the prototype Fang-shan plant.

We estimate that China's synthetic rubber production capacity from petroleum feedstocks was 25,000 mt/yr in 1970, all from the Lan-chou complex. This figure includes the capacities of both the imported rubber plant and the older grain-alcohol-based plant which was apparently being converted to the use of petrochemical feedstock. With the completion of the Fang-shan and Wang-chu-chuang plants, China's total projected synthetic rubber production capacity increased to about 51,000 mt/yr by the end of 1975, but actual production of synthetic rubber has probably been significantly less. Except for the Chi-lin-hsiang plant, no synthetic rubber plants are known to be under construction.

No synthetic rubber plants were included in the plants imported between 1973 and 1975 for construction at the Fang-shan, Chin-shan-wei, and Liao-yang complexes. The three new ethylene plants at these complexes could, however, produce a combined total of about 74,000 mt/yr of butadiene, a basic feedstock for synthetic rubber production. The Chinese apparently do not have the capability to design and construct synthetic rubber plants of a scale large enough to use these available quantities of feedstock. They may, therefore, decide to purchase large-scale rubber plants just as they have purchased plastics and synthetic fibers plants.

Trends

The future output of petrochemical products will depend largely upon the rate at which the Chinese purchase large-scale whole plants and their ability to construct these plants. This is especially important for the future synthetic rubber production, since butadiene feedstock will be readily available to supply such plants. Equally important to the future of the petrochemical industry is the degree of success the Chinese have in copying some of the new large-capacity plants they have imported. They are currently attempting to construct a second ethylene plant at Lan-chou patterned after the imported ethylene plant already at that complex. Despite these limiting conditions, it appears that the Chinese petrochemical industry will continue to expand rapidly at least through 1978 and probably into the 1980s.

## PETROCHEMICAL COMBINE AND PLANT DESCRIPTIONS

This section provides basic descriptions and annotated photographs of each of the ten known Chinese petrochemical facilities. These descriptions include major petrochemical products, locations (including nearby related plants), transportation connections, and a construction chronology. In most cases, we also provide a table summarizing each major processing area, including function or product(s), estimated production capacity where possible, source of equipment, the years in which construction was begun and completed, and other pertinent remarks.



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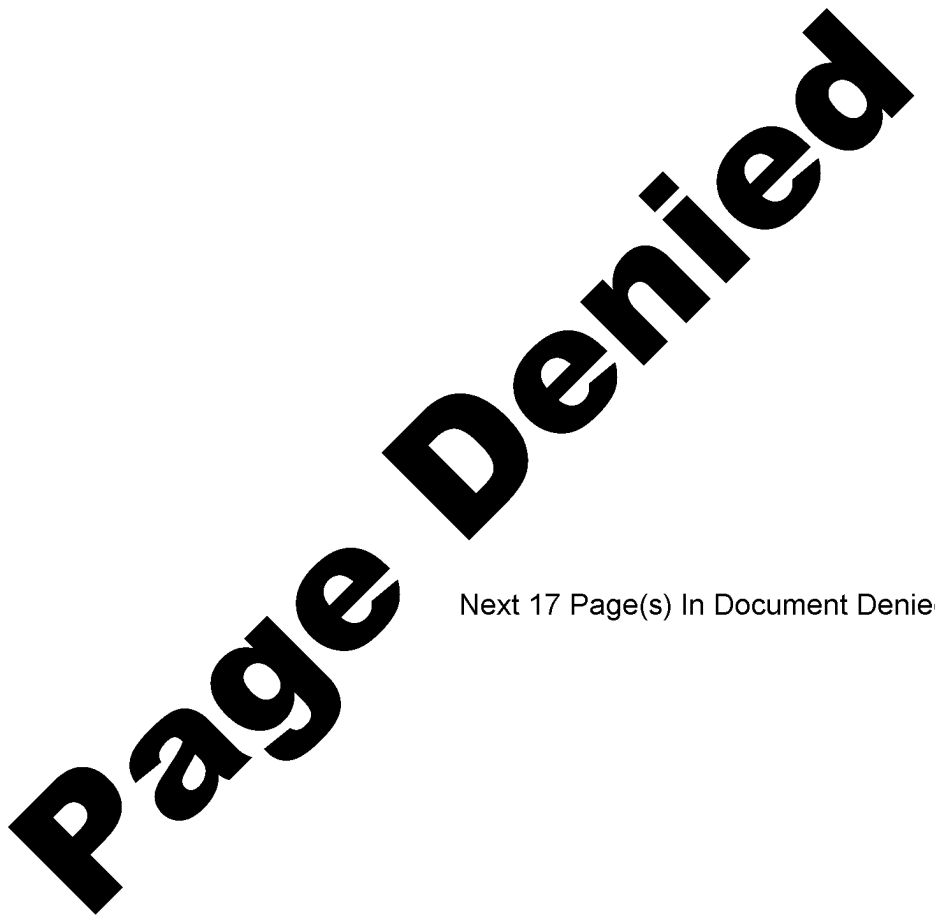


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## Requirement

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